EEG Brain Waves Pattern Analysis on the Specified Human Daily Activity

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Abstract. This paper describes about EEG brain wave's pattern analysis related to human specific daily activities. EEG is a study of changing electric potential of the brain. As we know, brain is one of the most complex systems in the universe. This study proposes a simple way to analyze some EEG data due to human activities. It shows that there are distinct different brain waves pattern for different daily activities including sleeping, reading and music listening. Some of these activities will tire our bodies. This paper also gave brain waves pattern comparisons between tired brain and tired body.

Keywords: Electroencephalogram (EEG), brain waves, data visualization, light sleep, deep sleep

1 Introduction

The human brain is arguably one of the most complex systems throughout the universe [1].The difference between human and other living thing are common sense. Over the centuries, it has been the objective of many studies, and until today, many of its functions are not completely known or understood [2]. Human brain controls and co-ordinates everything we do. Its purposes are to receive messages, process those messages and respond to them. These responses generated by the brain allow us to think, breathe, speak, show emotion and regulate all of our other bodily functions [3].

Human brain can be regarded as a signal-processing unit producing actions and reactions to sensory inputs [4]. Nowadays, various technologies exist to record brain waves,e.g.,electroencephalograms(EEG),magnetoencephalograms(MEG), and functional MRI (fMRI) [1]. A commonly used tool to investigate brain activity is the EEG [5].

EEG is a study of changing electric potential of the brain, and it measures brainwaves of different frequencies within the brain [7]. The Electroencephalogram machine in today's science as a non-invasive method and with the capability of long-term monitoring of the EEG signal plays an important role in brain examination and study [2]. EEG is mostly monitored by a system of multiple electrodes [4]. The electrodes are placed on specific sites on the scalp to detect and record the electrical impulses within the brain [7]. EEG has the information which is difficult to obtain

by the direct observation of data [8].

This tool allows researchers to gain understanding of the complex inner mechanisms within the brain [1]. EEG energy analysis is used to evaluate the brain activity [6]. EEG data can be formed in many patterns due to our bodies' response and activities. This paper will show the different brain waves pattern on our specified human daily activities.

2 Methodology

The work reported here is the result of research collaboration with Department of Surgery, Kulliyyah of Medicine, International Islamic University Malaysia (IIUM), and Neurology Department, Hospital Tengku Ampuan Afzan (HTAA) through our EEG hardware recording. The target of the research is to learn and get some information for the real protocols guide for EEG. The research has been conducted by two neurologists from HTAA, who are also lecturers from the Department of Surgery, Kulliyyah of Medicine,(IIUM). The EEG room medical assistant (MA) will be showing the EEG protocols on how to conduct the EEG hardware while the neurologist will be giving the explanation. The data collected for this study has been obtained from various activities performed by a postgraduate student using the EEG hardware recorder at different times for different activities. The activities have been conducted at postgraduate research room, and in Biofeedback Lab, University Malaysia Pahang (UMP) .The data collection was done by our EEG hardware recorder. EEG recorder is a complex tool and needs regular preparations. The preparations include the software setup and hardware setup. The data was be analyzed using the visualization process. This process will be done regularly for every activity. The result from the data visualization will indicate the direction for our future research.

3 Data Collection and Data Acquisition

Data was collected for activities in different environment such as deep sleep (sleep with light off), light sleep(sleep with light on), reading, relaxing and resting in tired condition. An example of a data sample collected for reading activity is as shown in Figure 1(a). The EEG data was collected from a male postgraduate student of UMP. The EEG data is in random form, therefore it needs some kind of data cleaning processes to ensure that only relevant data are analyzed.

MINUTES	DELTA	THETA	ALPHA	LOBET	BETA	HIBET	GAMMA
1	8.32	6	7.21	4.79	4.75	3.82	1.39
1	7.14	11.57	20.08	10.54	12.58	12.26	1.07
1	8.93	3.67	2.81	2.02	1.72	1.16	0.78
1	1.77	5.14	10.04	13.24	17.29	24.07	28.79
2	17.38	10.02	11.9	5.27	5.4	4.07	1.7
2	8.42	12.88	24.44	8.39	9.19	8.75	0.7
2	22.57	10.66	6.71	2.56	2.67	1.71	1.64
2	1.79	5.19	10.01	13.09	17.24	24.16	30.7
3	10.25	7.95	9.32	5.01	4.89	4.44	1.4
3	8.04	13.69	20.49	8.93	10.46	11.43	0.69
3	6.02	4.42	4.6	2.22	1.62	1.25	0.61
3	1.79	5.21	9.97	13.17	17.27	23.92	39.25
4	9.11	6.89	7.79	4.41	4.7	4.36	1.32
4	8.21	13.45	19.32	8.9	11.31	12.88	0.63
4	5.83	3.67	3.82	1.97	1.74	1.13	0.69
4	1.8	5.23	9.91	13.18	17.43	23.64	38.58
5	39.81	25.13	19.56	14.1	14.69	13.38	5.22
5	8.59	13.33	13.09	7.86	10.64	12.57	1.9
5	31.9	17.92	14.88	9.72	10.12	8.94	5.25
5	1.79	5.24	9.84	13.36	17.34	24.04	38.03

Fig. 1(a). Data Sample

3.1 Data Analysis

The data was analysed by creating a formula in Microsoft Excel as follows:

a) Maximum value

```
=MAX (Ca:Cb)
  Where,
          a=first selected data
          b=last selected data
          C=column and row
```

b) Minimum value

```
=MIN (Ca:Cb)
  Where,
          a=first selected data
          b=last selected data
          C=column and row
```

c) Avarage

```
=AVARAGE (Ca:Cb)
  Where,
          a=first selected data
          b=last selected data
          C=column and row
```

d) The data number count

```
=COUNTIFS(C$a:C$b,CONCATENATE(">=",$Ac), C$a:C$b,CONCATENATE("<=",$B81))
  Where,
          a=first selected data
          b=last selected data
          c= the result to analysis
         A,B, C=column and row
```

The data analysis of the data sample shown in figure 1(a) resulted in the data summary as illustrated in figure 1 (b) and figure 1 (c).

MAX	51.94	46.3	35.19	21.2	20.94	24.64
MIN	1.68	1.94	2.81	1.9	1.62	1.1
AVARAGE	12.51425	12.504	14.0985	9.436875	10.90175	12.34825
RANGE(MAX-MIN)	50.26	44.36	32.38	19.3	19.32	23.54

Fig. 1(b) . Maximum and Minimum

		Delta	Theta	Alpha	Lobeta	Beta	Hibeta	Gamma
0	10	30	28	50	40	35	31	40
11	20	12	25	10	21	25	17	7
21	30	8	6	1	3	4	16	1
31	40	4	1	1	2	2	1	12
41	50	2	0	2	0	0	1	5
51	60	2	1	3	0	0	0	0
61	70	2	4	0	0	0	0	1
71	80	2	1	0	0	0	0	0
81	90	3	0	0	0	0	0	0
91	100	1	0	0	0	0	0	0

Fig. 1(c). Data Counting

3.2 Data visualization

Data visualization is the study of the visual representation of data, which has been abstracted in some schematic form, including attributes or variables for the units of information [9]. By data visualization, we can manage the data according to their axis. Figure 1(d) illustrates a snapshot of data visualization where the x-axis showed the time in minutes and the y–axis showed delta and theta values. This is illustrated in figure 2(a)-2(f). The results will be discussed in the next section.

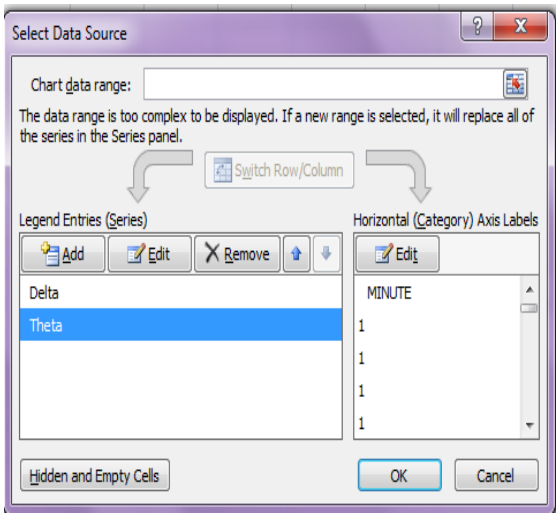

Fig. 1(d) . Data Visualization

4 Result and Discussion

Every activity will produce different wave's pattern. The result is illustrated as in figure 2(a) - 2(f).

4.1 Sleep Moment

Figure 2(a) and 2(b) show the comparisons between deep sleep and light sleep wave's pattern respectively

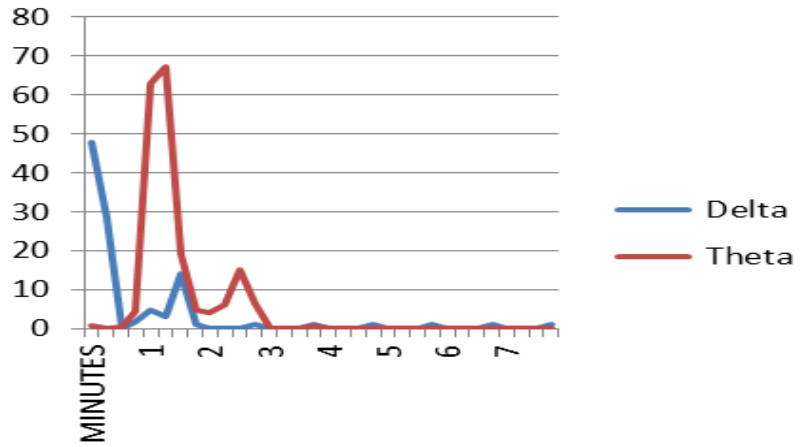

Fig. 2(a) . Deep Sleep

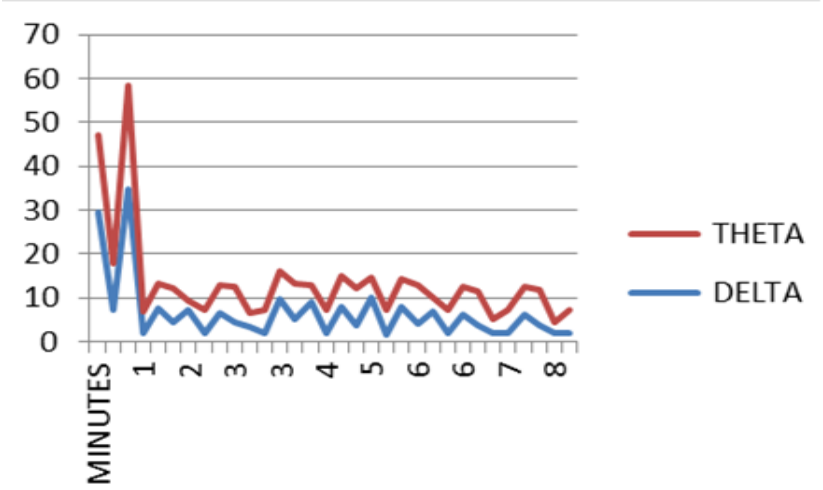

Fig. 2(b) . Light Sleep

The deep sleep is illustrated by the smooth line on the x-exist. The results are similar to what had been described by Sleepdex [10] . Sleep pass through five stages: 1, 2, 3, 4 and REM (rapid eye movement). Every stage will produce the different frequency as shown in table 1

Table 1: Sleep Stages and Frequencies

Stages	Frequency (hz)
1	4-8
2	4-15
3	2-4
4	0.4-2
REM	15-30

The brain produces delta waves almost exclusively. Stages 3 and 4 are referred to as deep sleep or delta sleep and it is very difficult to wake someone from them. In deep sleep, there is no eye movement or muscle activity [10]. Light sleep is where you drift in and out of sleep and can be awakened easily,the eyes move slowly and muscle activity slows [10].

4.2 Tired Moment

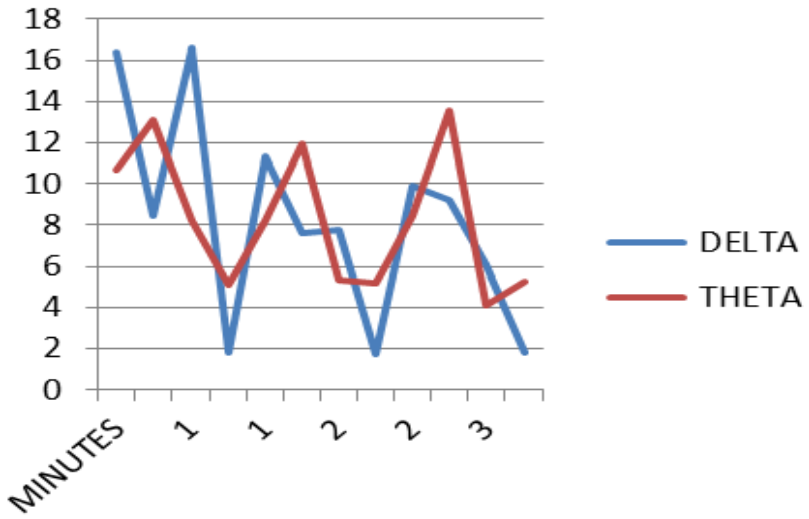

Fig. 2(c) . Tired Brain

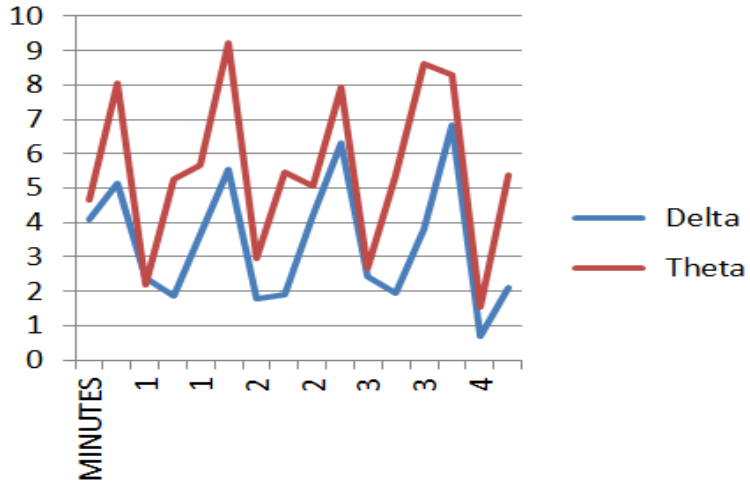

Fig. 2(d) . Tired Body

Figure 2(c) and 2(d) show the comparisons between brain and body waves pattern in the tired mode. Usually, our brain becomes tired because of too much thinking, works and stress which can cause headache. Daily activities like that require some energy like taking part in sport, study and working can make our body tired. Tired brain has a higher hz reading than tired body. This is because tired body does not mean that the brain cannot function properly but tired brain can affect the whole body system.

4.3 Normal Activity

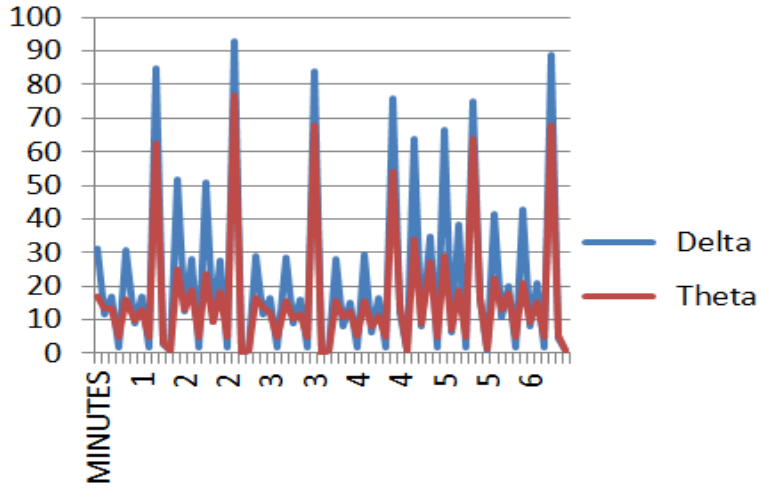

Fig. 3(e). Relaxed

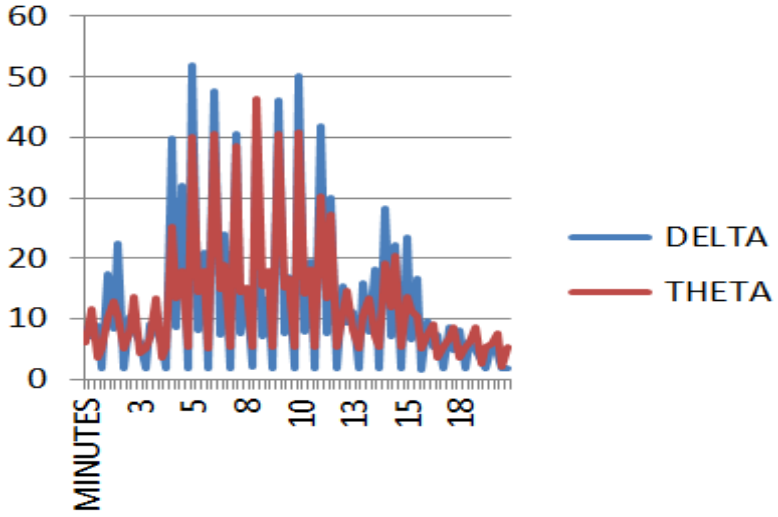

Fig. 3(f) . Study and Learning

Figure 2(e) shows the wave's pattern for brain in the relaxed atmosphere. The hz reading can reach up to 90. This indicates the highest concentration of the mind. In a relaxed atmosphere, we manage do the simple breathing as the best way to increase our concentration. Figure 2(f) shows the result during study and learning activities. Usually, the concentration is lower at the early stage of the activity. The result shows that the concentration for a normal person increases after 4 minutes and decreases after 12 minutes. The brain concentration cannot be maintained longer than the normal duration as it cannot focus on certain activities

5 Conclusion

The data analysis from our EEG hardware can give enough information about EEG waves reading due to human activities. Explanation of our results about our brain wave pattern due to certain activities can give some awareness on how to protect our brain. The results showed that every activity will give different brain wave patterns. Tired brain shows higher reading than a tired body. Usually tired brain can affect the performance of our bodies and if not checked can cause headache and body pain. This research also showed that the best sleep is in a relaxed condition and simple breathing while doing certain activities can increase our concentration in doing our work. Further research will be performed on human to analyze the wave patterns of healthy and unhealthy individual to facilitate early detection of chronic decease like tumor and cancer.

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